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(54) APPARATUS FOR VIBRATING A LIQUID

(71) We, DAWE INSTRUMENTS LIMITED, a British Company of Concord Road, Western Avenue, London W3 0SD, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed to be particularly described in and by the following statement:—

This invention relates to apparatus for vibrating a liquid and is particularly concerned with ultrasonic or sonic cleaning apparatus.

Apparatus for vibrating a liquid, according to the invention, includes a plurality of electro-mechanical transducers for producing vibrations, each transducer including an end plate which vibrates when the transducer is energised in use, the end plates of said plurality of transducers being formed integrally with one another so that together they define a first radiating surface, grooves being provided in said first radiating surface between adjacent transducers respectively so that, in use, vibration of the first radiating surface is substantially restricted to a direction normal to said surface and the apparatus further including a second radiating surface through which vibrational energy is supplied, in use, to said liquid to cause it to vibrate, the second radiating surface defining with said first radiating surface a space for receiving a liquid medium capable of transmitting vibrations from the first radiating surface to the second radiating surface.

The accompanying drawing is a diagrammatic illustration of part of ultrasonic cleaning apparatus according to one example of the invention.

Referring to the drawing, the apparatus includes a container 13 in which is situated a plurality of electro-mechanical transducers 14, each transducer 14 including a pair of silvered piezo-electric discs 15 trapped with a central electrode (not shown) between first and second end plates 16, 17 respectively. The end plates 16 are formed as integral parts of a single vibration member 18, which is provided in its surface 19 remote from

the discs 15 with grooves 21 which extend between adjacent transducers 14 respectively. The grooves 21 serve to decouple adjacent transducers 14 so that, in use, when the transducers are energised vibration of the surface 19 is substantially restricted to a direction normal to the surface 19.

The member 18 is secured to the container 13 by way of a bracket 22 arranged so that the surface 19 defines a space 23 with an adjacent wall 12 of the container 13. A gasket 24 is interposed between the bracket 22 and the member 18 so that the space 23 is liquid-tight and received in the space 23 is a liquid 25 capable of transmitting vibrations from the surface 19 to the wall 12 of the container 13. In use, the container 13 is received in an ultrasonic cleaning bath containing a liquid which readily undergoes cavitation, the arrangement being such that the wall 12 is immersed in the cleaning liquid which conveniently is water together with a suitable cleaning agent. Then, when it is required to ultrasonically clean an article, alternating current is supplied to the transducers 14 so that the transducers impart ultrasonic vibrations to the surface 19 which defines a first radiating surface and transmits the vibrational energy to the liquid 25. The vibrational energy is then transmitted by the liquid 25 to the wall 12, which defines a second radiating surface and imparts the ultrasonic vibrations to the cleaning liquid so as to cause the liquid to cavitate and thereby impart a cleaning action to the article when immersed therein.

Preferably, the liquid 25 is chosen so that when subjected to the vibrational energy supplied by the transducers 14 in use, it undergoes cavitation by an amount not exceeding 25% of the amount of cavitation in the cleaning liquid. More preferably, the amount of cavitation produced in the liquid 25 when subjected to the vibrational energy supplied by the transducers 14 does not exceed 20% and most preferably, does not exceed 10% of the amount of cavitation

produced in the cleaning liquid. A suitable liquid 25 is ethylene glycol and using the liquid 25 it is found that there is a marked decrease in the rate of localised cavitation erosion which can otherwise arise in a conventional high intensity ultrasonic cleaning system where a plurality of transducers are bonded directly to the radiating surface which transmits the ultrasonic vibrations to the cleaning liquid.

In one practical example, in which the liquid 25 was ethylene glycol and the cleaning liquid was water together with a suitable cleaning agent, it was found that when the vibrational energy supplied by the transducers 14 to the first radiating surface was 10 watts the amount of cavitation produced in the ethylene glycol was 10% of the amount of cavitation produced in the water/cleaning agent mixture.

In a modification (not shown), the wall 12 of the container 13 is secured to an external surface of an ultrasonic cleaning tank, in which case the wall 12 is conveniently defined by a closure plate which can be removed from the remainder of the container 13 and the cleaning bath to facilitate replacement of the wall 12.

30 WHAT WE CLAIM IS:—

1. Apparatus for vibrating a liquid, including a plurality of electro-mechanical transducers for producing vibrations, each transducer including an end plate which vibrates when the transducer is energised in use, the end plates of said plurality of transducers being formed integrally with one another so that together they define a first radiating surface, grooves being provided in said first radiating surface between adjacent transducers respectively so that, in use, vibration of the first radiating surface is substantially restricted to a direction normal to said surface and the apparatus further

including a second radiating surface through which vibrational energy is supplied, in use, to said liquid to cause it to vibrate, the second radiating surface defining with said first radiating surface a space for receiving a liquid medium capable of transmitting vibrations from the first radiating surface to the second radiating surface.

2. Cleaning apparatus including a first liquid which, in use, defines a cleaning agent and which will undergo cavitation when vibrational energy is supplied thereto, apparatus as claimed in Claim 1 for vibrating said first liquid, and a second liquid which defines said liquid medium and which is interposed between the first and second surfaces, said second liquid being such that any cavitation produced therein when the medium is subjected to the vibrational energy supplied by the transducers, in use, does not exceed 25% of the amount of the cavitation produced in said first liquid.

3. Apparatus as claimed in Claim 2, wherein said second liquid is such that any cavitation produced in said second liquid does not exceed 20% of the amount of cavitation produced in said first liquid.

4. Apparatus as claimed in Claim 2, wherein said second liquid is such that any cavitation produced therein does not exceed 10% of the amount of cavitation produced in said first liquid.

5. Apparatus as claimed in any one of Claims 2 to 4, wherein said second liquid is ethylene glycol.

6. Apparatus for vibrating a liquid comprising the combination and arrangement of parts substantially as hereinbefore described with reference to the accompanying drawings.

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